



Using Low-Cost NO₂ Sensors to Understand Ozone Formation in Maricopa County

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Overview

- Background
- Purpose
- Calibration
- Analysis
- Results
- Conclusion

Background

- Maricopa County experiences challenges in meeting the national ambient air quality standards (NAAQS) for ozone.
- Maricopa County Air Quality Department (MCAQD) engages in collaborations with other government and academic partners to gain understanding of air quality issues that affect the region.

Purpose

In July 2021, MCAQD entered a partnership with Arizona State University (ASU) to better understand how NO₂ contributes to ozone formation in Maricopa County.

- Clarity Node-S low-cost sensors (LCS) study

Initial Calibration

- Prior to ozone season
- 12 LCS collocated for calibration with federal reference method (FRM) NO₂ and federal equivalent method (FEM) ozone monitors
- Miech *et al*, 2021

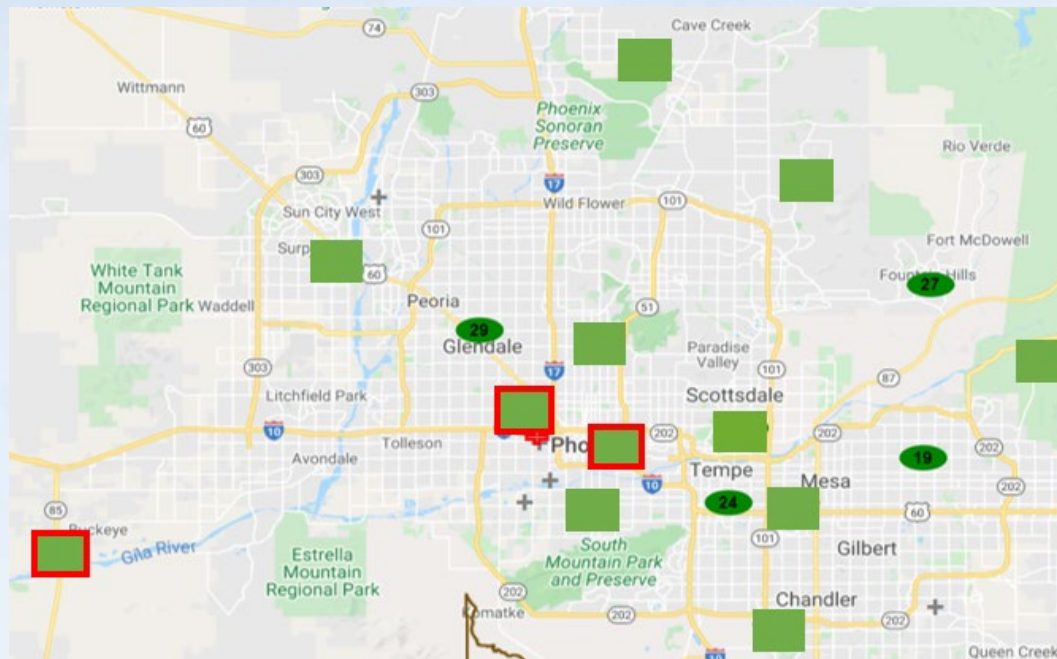


Periodic Calibration Checks

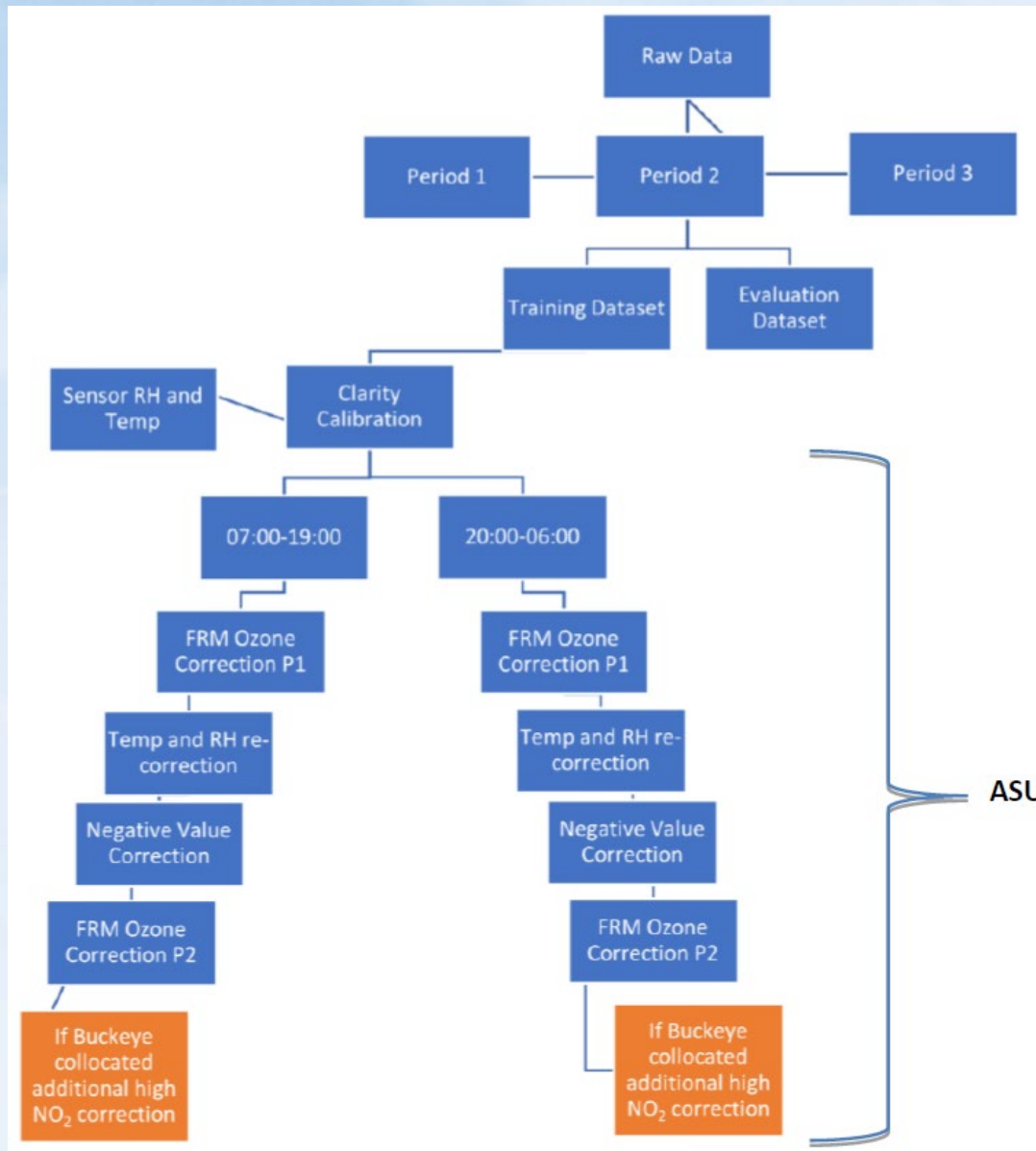
During ozone season
(May – September)

- LCS periodic calibration rotation: 12 sites

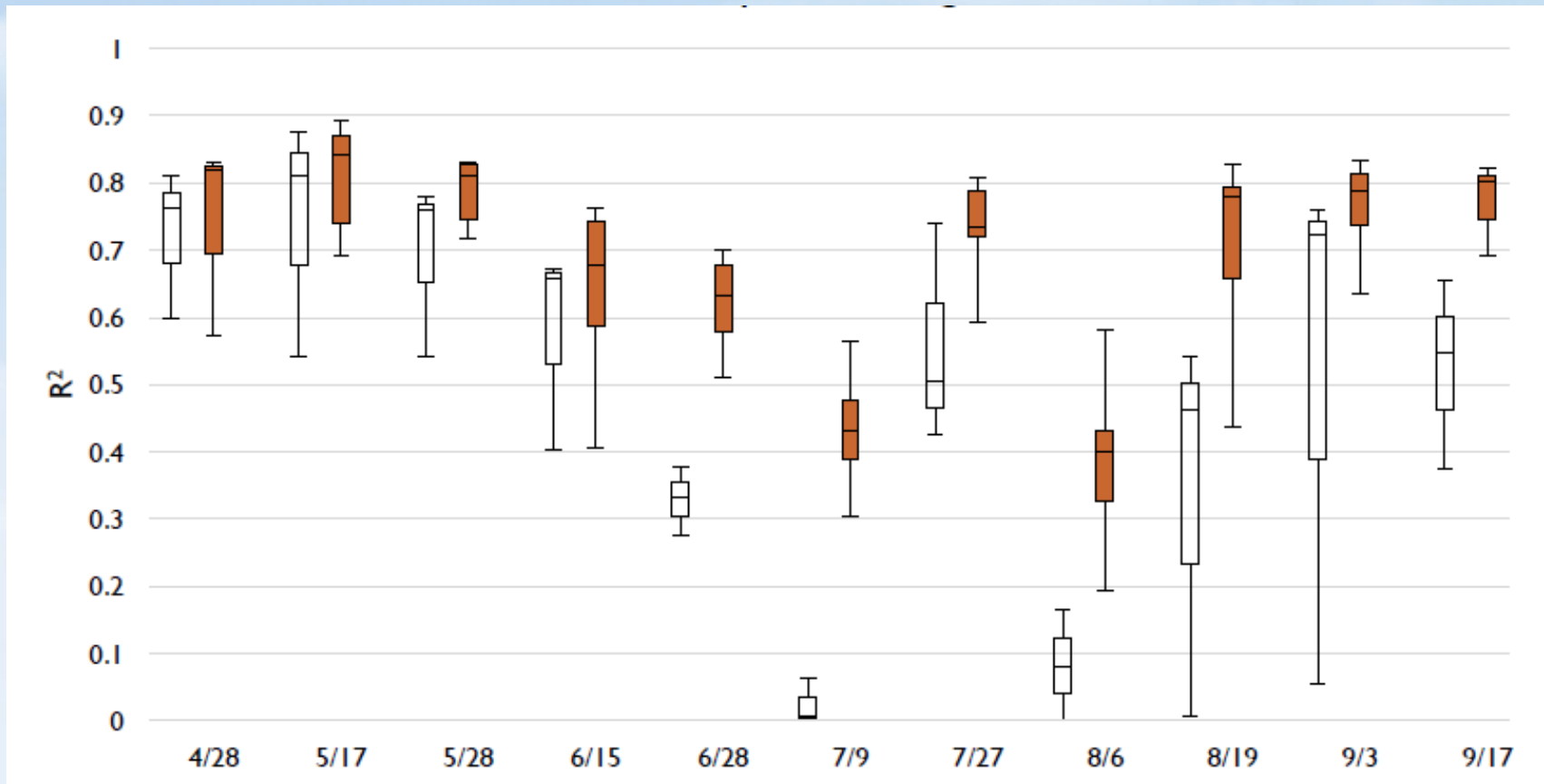
- 2 weeks at site with FRM NO₂ monitor (red)
- 6 weeks at site without FRM NO₂ monitor (green)



LCS Calibration



Initial vs. Period Specific Calibration



Initial Calibration



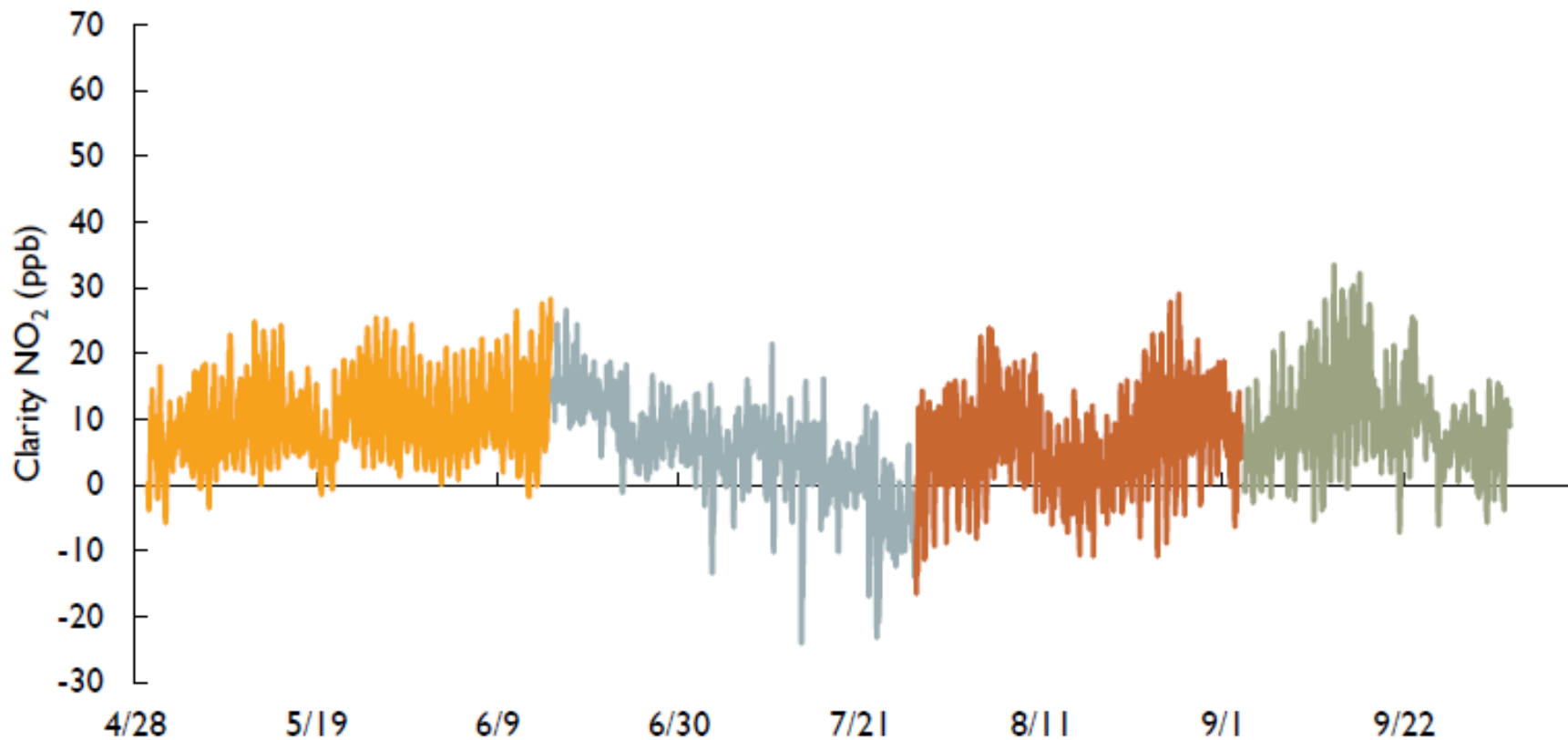
Period Specific Calibration

Original Clarity Calibration



Mesa

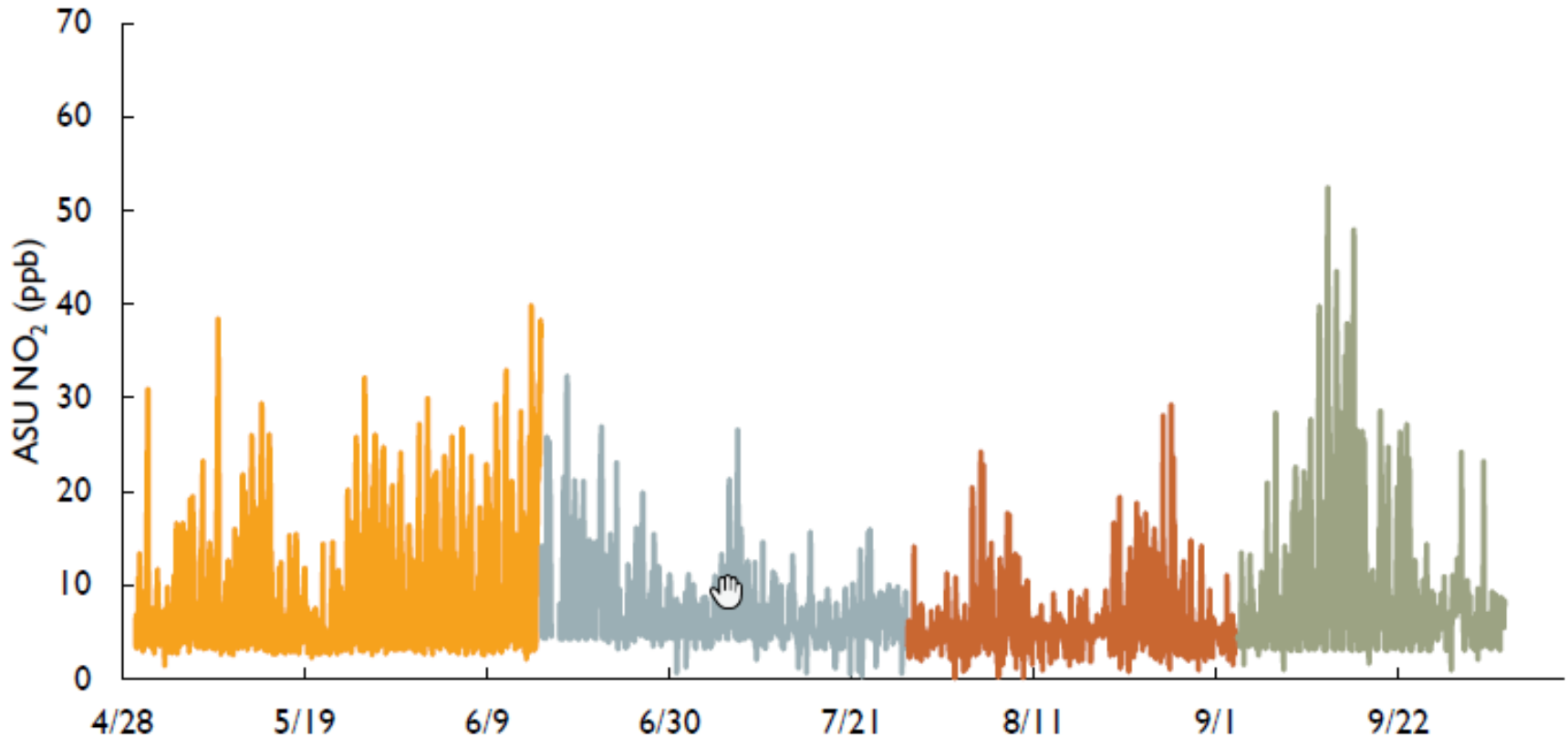
Sensor 11 Sensor 8 Sensor 2 Sensor 5



ASU Period Specific Calibration

Mesa

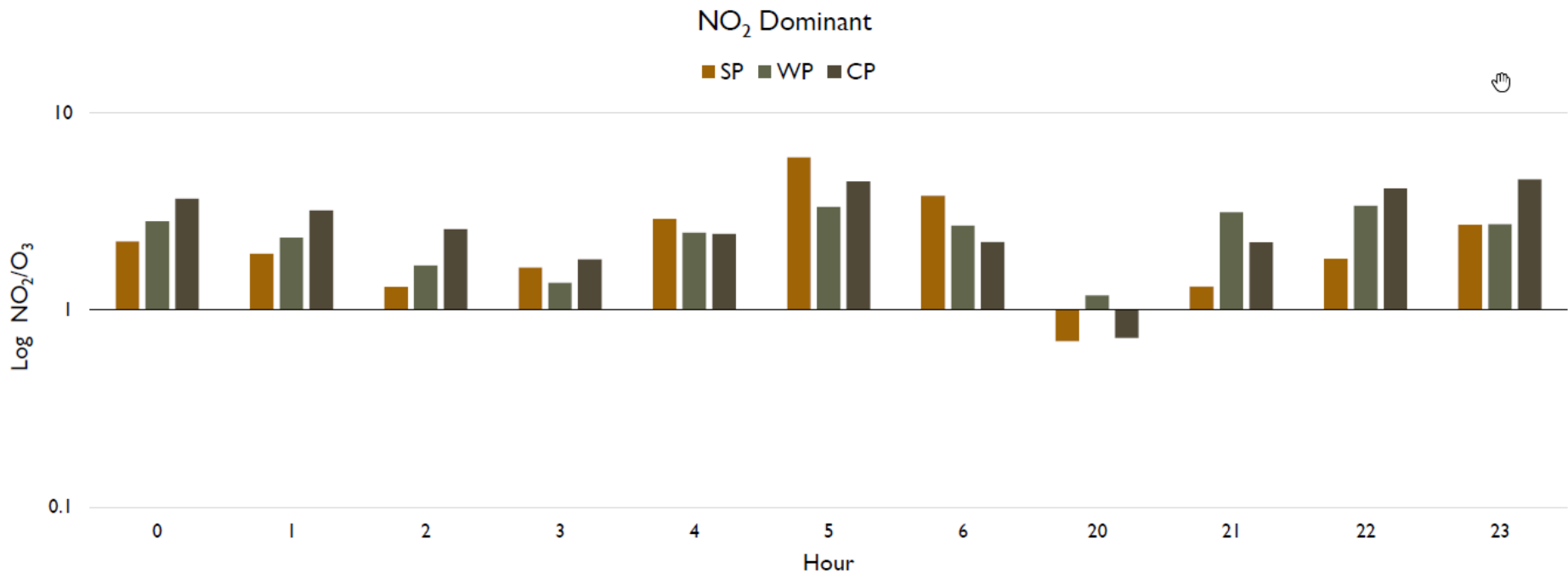
— Sensor 11 — Sensor 8 — Sensor 2 — Sensor 5



Analysis

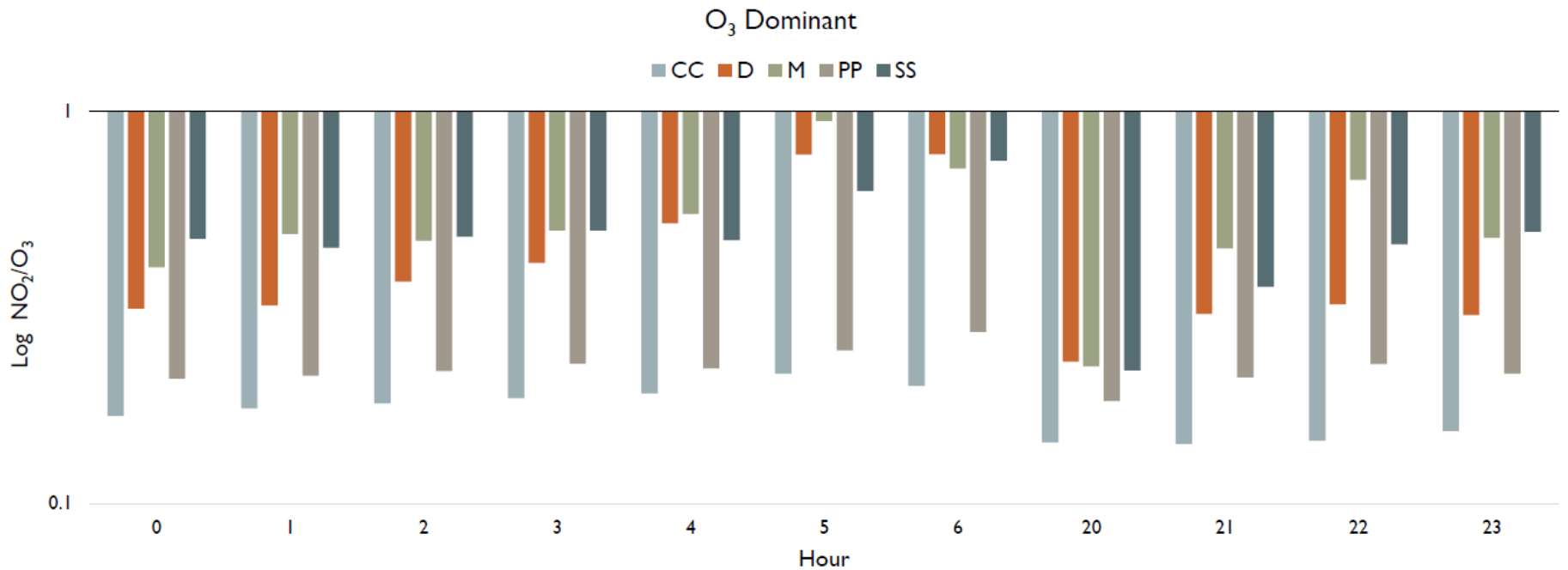
- Using the period specific calibrated LCS data
 - Compared the log (NO_2 /ozone) to better understand impact of NO_2 on ozone formation.
- Three possible ratios consistent with different NO_2 and ozone relationships
 - 1) NO_2 dominant
 - 2) Ozone dominant
 - 3) Equivalent NO_2 to ozone proportions

NO₂ Dominant Sites



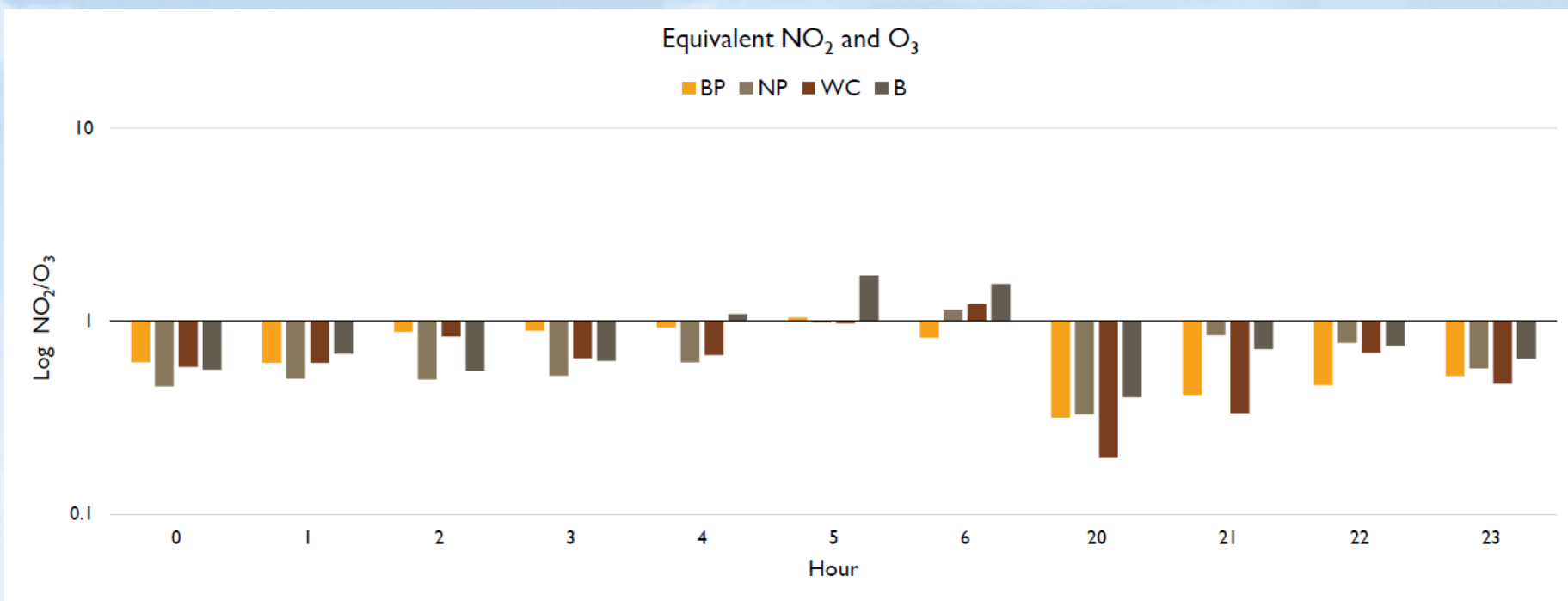
South Phoenix (SP)
West Phoenix (WP)
Central Phoenix (CP)

Ozone Dominant Sites



Cave Creek (CC)
Dysart (D)
Mesa (M)
Pinnacle Peak (PP)
South Scottsdale (SS)

NO₂ / Ozone Equivalent Sites



Blue Point (BP)
North Phoenix (NP)
West Chandler (WC)
Buckeye (B)

Results Summary

- Three urban cores sites NO₂ dominated
 - SP, WP, and CP
- Peripheral monitoring sites outside urban core ozone dominated
 - CC, D, M, PP, and SS
- Upwind or more rural sites tend toward equivalent ratios of NO₂ to ozone
 - BP, NP, and B

Wildfire Smoke

- June 15, 2022
 - Transported wildfire smoke present
 - Morning NO₂ concentrations within usual ranges
 - All sites except Dysart and Cave Creek
 - Ozone exceedances at 13 sites
 - 0.108 ppm at North Phoenix
 - 0.107 ppm at Pinnacle Peak
 - Six other sites > 0.090 ppm
- ASU found that VOCs from smoke shifted the region to NO_x-limited conditions

Conclusion

- LCS can aid in better understanding the distribution of NO₂ concentrations over a large area.
- When a high degree of accuracy is required, LCS require a large amount of effort to periodically recalibrate the LCS from FRM NO₂ and FEM ozone measurements.

Questions



Thank you.

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